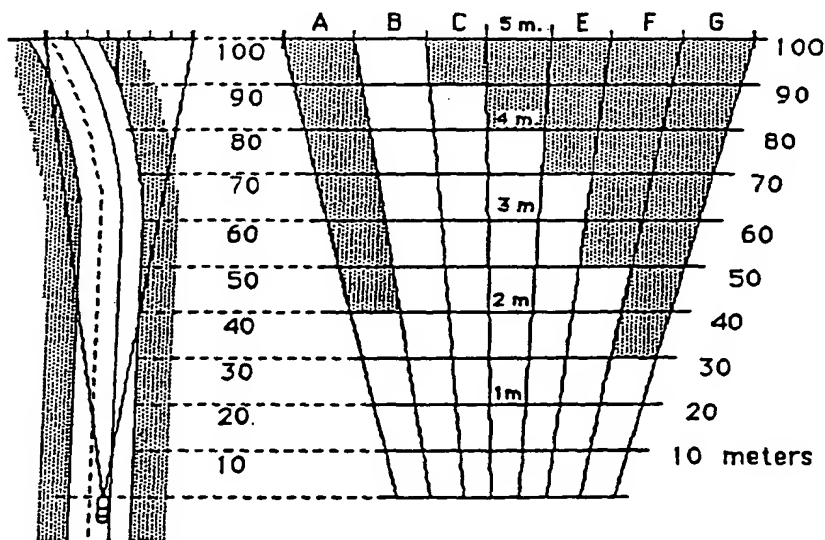




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/IT89/00002</p> <p>(22) International Filing Date: 16 January 1989 (16.01.89)</p> <p>(31) Priority Application Number: 47545 A/88</p> <p>(32) Priority Date: 18 January 1988 (18.01.88)</p> <p>(33) Priority Country: IT</p> <p>(71)(72) Applicant and Inventor: PAOLETTI, Paolo, Alberto [IT/IT]; Via Luigi Rizzo, 62, I-00136 Rome (IT).</p> <p>(74) Agents: TALIERCIO, Antonio et al.; Ing. Barzanò &amp; Zanardo S.p.A., Via Piemonte, 26, I-00187 Rome (IT).</p> <p>(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent),</p>	<p>HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.</p> <p><b>Published</b>  <i>With international search report.          Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>	

## (54) Title: VEHICULAR ANTICOLLISION RADAR SYSTEM



## (57) Abstract

The space ahead of a moving vehicle is irradiated in sectors (A-G) by a plurality of CW solid state radar devices mounted as an array across the front of the vehicle, such that adjacent lobes of each beam may overlap. The radar signal comprises a CW beam modulated intermittently by a slightly offset frequency to produce 'pulses' which when reflected from obstacles within respective sectors (A-G) are detected by mixer diodes in one, or two adjacent radar devices after a time delay which, when measured, yields a distance to the obstacle. Obstacles so detected may be displayed in two dimensions within their respective sector (A-G) on a display projected onto the windscreen.

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VEHICULAR ANTICOLLISION RADAR SYSTEM

To drive a vehicle in the fog with no visibility, it is not sufficient an equipment signalling only the presence of obstacles or free way before the vehicle, even if completed with the indication of the minimum distance between the obstacles and the vehicle, but it is also necessary to know their location with more details, so that it be possible to take decisions about the movements to perform, especially in proximity of curves, if to the right hand side or to the left hand side or also to overtake if there is ahead a too slow vehicle. Therefore it is required to indicate the geometry of the free space in front of the vehicle by employing a bidimensional quadrant, consisting for example of numerous spots that lighten red or green in each narrow sector ahead if there is or there is not an obstacle (figure 1). Such a quadrant could be located upon the dashpanel in such a manner that the luminous image be reflected by the windscreen toward the driver, thus consenting him to look at it together with the road.

In other words the problem is to measure the coordinates of eventual obstacles. We will use polar coordinates: with reference to figure 3, we will call distance (from obstacle) the measure of the radial vector  $R = OH$  and declination the angle  $Z$  formed by the radial vector with the vertical axis  $y$ .

The measure of  $R$  may be deduced from the measure of the time  $t$  required by an electromagnetic radiation to propagate

- 2 -

from the antenna located in O up to the obstacle H, reflected by H and back into O. Given c the propagation velocity, we get:

$$R = c \cdot t / 2 .$$

For measuring the angle Z we may employ n microwave  
5 beams irradiated by small fixed antennas, slightly divergent, for  
consenting the exploration of the areas belonging to  $2n-1$  sectors,  
as indicated for example in figure 2 where  $n=3$ . In this figure we  
may distinguish five angular sectors and therefore quantize the  
angle Z in five parts: if an obstacle is located for instance in the  
10 center line of sector B, it will be detected only through the beam  
B; if it is located in intermediate position, for instance in sector  
A+B, it will be detected by both beam A and beam B.

This technique, that we define "amplitude discrimination",  
seems recalling that of the monopulse radar used in automatic  
15 tracking systems, but it is not exact: in fact such systems are  
effective when there is only one target, but less efficient when  
the targets are more than one, especially if the targets are  
equidistant from radar and are clustered. On the contrary we  
intend to signal every each obstacle, with an accuracy  
20 satisfactory for most practical obstacle configurations. The most  
difficult configurations to be correctly detected are those with  
obstacles all aligned at the same distance R from the antennas;  
but, save particular cases that however do not lessen the safety  
given by the system, it supplies yet sufficient informations for a  
25 cautious driving.

The procedure to be adopted is the following. Let us  
suppose, for simplicity,  $n=3$  (figure 2): the three beams belong to

- 3 -

the three antennas A, B, C, that are at the same time transmitting and receiving, and therefore connected to respective transmitters and receivers. A short radiofrequency pulse is emitted one at a time by each of the three transmitters, while  
5 the three receivers are always abilitated contemporaneously. Let us suppose now that a pulse be emitted only by antenna A and that there is only one obstacle entirely situated in sector A (ref. figure 2), at distance R from antenna: after a certain time the echo consequent to the reflection on the obstacle is received by  
10 antenna A, but not by antenna B neither by antenna C; if the obstacle is in sector A+B the echo is received by antennas A and B, but not by antenna C. The next pulse be emitted by antenna B: the same obstacle in sector A+B will reflect an echo received practically at the same instant by antennas B and A and not by  
15 antenna C; but if the obstacle is situated in sector B it will reflect an echo received only by antenna B.

It is understood that two and also three distinct aligned obstacles, situated at the same distance R from the antennas and contained one in sector A, the other in sector B and the third in  
20 sector C - without affecting sector A+B or sector B+C - can be distinctly recognized by the apparatus, since the system receives at the first time the echo signal only with antenna A, at a second time with antenna B, and at a third time only with antenna C, but never simultaneously with antennas A and B or antennas B  
25 and C.

The simultaneous reception happens, for geometrical considerations, when an obstacle is situated in one of the

- 4 -

common sectors, for instance in sector A+B and at the distance R from the antennas. In fact an impulse transmitted by antenna A intercepts the obstacle and returns as an echo to both antenna A and antenna B, and viceversa an impulse transmitted by antenna B intercepts the obstacle and returns as an echo to both antennas B and A. This happens independently whether sector A and/or sector B are or are not free from obstacles, since it is not possible to distinguish if also sectors A and B are or are not occupied by obstacles at the same distance R, save a further manipulation of signals such to consent also the above said distinction. To avoiding such manipulation it is reasonable to assume the worse case, like that the sectors A and B also contain obstacles aligned with the obstacle in sector A+B at the same distance R: it is therefore necessary to give a signalling equivalent to a single obstacle at the distance R with a span covering all three sectors A, A+B and B. This signalling choice does not constitute a significant limitation of the system: we shall not forget in fact that we operate in the fog, where we have to discourage hazardous manoeuvres. Let us extend now the reasoning to sector C, in which at the same distance R we suppose another obstacle is contained, but none in sector B+C: then the sector B+C will be shown as being free from obstacles, whereas sector C will signal the obstacle. In conclusion with the described beams we obtain full angular information on how to proceed in the fog. In addition road delimiting guard-rails or other detectable surfaces shown on the display will furnish a complete view of the space ahead of the driver; in fact for a full safe driving is necessary the

- 5 -

provision of microwave reflecting surfaces at the edges of roads and transit zones, where missing, to avoid trenches, ravines, etc.

When an obstacle is detected, for example in sector A at distance  $R = 50$  meters, it is foreseen that not only its warning light be lit, but also all the lights beyond it at increasing distances be lit, like shown in figure 1 for all spots pertaining to sector A at  $R = 50, 60, 70 \dots$  meters. This reflects simply the fact that the obstacle masks all what is in its shade cone, as normally happens in optics. This arrangement has also the advantage to shift into a necessity the excess of signalling previously described about the simultaneous reception.

The execution of the equipment requires three phases: the first phase relates to the study of the electromagnetic propagation and the selection of the microwave devices of the transmitting-receiving units with the respective antennas. The second phase relates to all those circuits actuating the most adequate modulations, amplifications and combinations of the emitted and received signals, with the scope to get the data required for the computations of  $R$  and  $Z$ . The third phase consists in the digital elaboration of the multitude of different data ( $R$  and  $Z$ ) related not only to a single obstacle but also to complex obstacle configurations to be indicated on the display; in fact the weak echo signals arriving to the receivers - after an adequate amplification - have necessarily to be interpreted, in accordance with the above described criteria, by means of a dedicated circuit which may be of a digital type and high speed of elaboration: this is feasible without difficulties with more or

- 6 -

less sophisticated technical solutions in view of the desired performance, so that no particular execution is detailed herein. The elaboration may result in a bidimensional display, for instance as that shown in figure 1. Likewise it is useless to  
5 digress on weak echo signal amplification from the receivers, since the executions are known by the present technics; the same can be said about transmitters and antennas. In conclusion the execution details of above said parts may vary amply from one construction to another, remaining in any case within the  
10 invention concept.

Now we expose, as a significant exemplification, the particular selections adopted to provide a simple prototype that can confirm the validity of our system. Let us use three identical resonant cavities gunnplexer at 10 GHz, each of which is able to  
15 generate and modulate a radiofrequency signal by means Gunn and varactor diodes, and detect the echo signal by means of the Schottky diode. Small and directional horn type antennas are applied to the cavities, such to form three narrow diverging beams, as shown in figure 2. The Gunn diodes are fed as directed  
20 and the cavities are calibrated to the same frequency  $f_1$ . An appropriate circuit, called modulator, generates very short tension pulses, each with the duration  $\tau$  of some tenths of nanoseconds, and provides to send them one at a time to each of the three varactor diodes in sequence; in this manner each cavity  
25 at a time oscillates for a short time interval  $\tau$  at frequency  $f_2 = f_1 + f_b$ , where  $f_b$  depends by the tension pulse applied to the varactor. A microwave train at frequency  $f_2$  is therefore emitted



- 7 -

for a time  $\tau$  by one of the antennas, hits the possible obstacle situated at distance  $R$ , and a small reflected portion returns into one or more antennas after a time  $t = 2 \cdot R/c$  (being  $c$  the propagation velocity of the wave train); from the antennas it is

5 conveyed into the corresponding receiving Schottky diodes. But in the meantime also the cavity that had transmitted the short oscillation at frequency  $f_2$  has resumed to oscillate at frequency  $f_1$ , and a small portion of this oscillation is also sent to its own Schottky diode, which consequently executes the product of the

10 two above mentioned oscillations at frequencies  $f_2$  and  $f_1$ . In conclusion at the output terminal of the Schottky diode of said cavity is present for a time  $\tau$  a signal of the following type:

$$u(t) = r(t) \cdot m(t) = A_2 \cos(2\pi f_2 t + \phi_2) \cdot A_1 \cos(2\pi f_1 t + \phi_1)$$

$$= A \cos[2\pi(f_2 + f_1)t + (\phi_2 + \phi_1)] + A \cos[2\pi(f_2 - f_1)t + (\phi_2 - \phi_1)]$$

15 where  $r(t)$  is the signal due to echo and  $m(t)$  the quantity due to the local oscillation  $f_1$ , and where:  $(A_2 \cdot A_1 / 2) = A$ .

This resultant  $u(t)$  is called beat of the two signals  $r(t)$  and  $m(t)$ , and consists of two components of equal amplitude  $A$ ; but, being  $f_1 \cong f_2 \cong 10$  GHz, the first component has frequency of about

20 20 GHz, of no interest and therefore will be filtered out; on the contrary the second component has a much lower frequency, and constitutes one of the three useful signals deriving from the microwave reflections on the obstacle. In fact also the remaining two cavities oscillates at frequency  $f_1$ , as we have said, and also

25 for them - in case of echo signal reception with frequency  $f_2$ , which happens if the obstacle is in the sector  $A+B$  or  $B+C$  - is valid the beat effect. In conclusion from the measure of time  $t$  between

- 8 -

the instant in which is emitted the short oscillation at frequency  $f_2$  and the instant in which the oscillation at frequency  $f_b$  emerges from one of the Schottky diodes, it is simple to obtain the distance  $R$  between the cavity and the obstacle with the  
5 equation:  $R = c \cdot t / 2$ .

The use of pulsive signals for the transmission consents to discriminate in depth, meaning that we can identify and distinguish several obstacles successively more far away with a resolution  $r$  which is bound to the pulse duration  $\tau$  by the  
10 equation:  $r = c \cdot \tau / 2$ .

The maximum distance (range)  $R_{\max}$  having interest to detect the obstacles establishes the pulse repetition frequency (P.R.F.), or the pulse timing  $T$  ( $T = 1/\text{P.R.F.}$ ), in accordance with equation:  $T_{\min} = R_{\max} / c$ . To avoid disadvantageous echo  
15 superimpositions (second-time-around echoes) it is necessary to use values  $T$  at least twice as much as  $T_{\min}$ . Thus, having foreseen for our prototype a range  $R_{\max} = 100$  meters (resulting  $T_{\min} = 0.67$  microseconds), we have selected the value of  $T$  equal to 2 microseconds. The figure 4, not to scale, indicates  
20 qualitatively the relationships among  $f_1$ ,  $f_2$ ,  $\tau$ ,  $T$ .

The selected subdivision of  $R_{\max}$  in segments of 10 nanoseconds each is sufficient to recognize the zones free from obstacles at the various distances (figure 1). To assure distinguishability among obstacles with reciprocal depth distances  
25 (i.e. in direction of  $R$ ) of at least ten meters, it is required a distance resolution  $r = 10$  meters: this means to operate with pulse duration not longer than  $\tau = 67$  nanoseconds. Therefore we

- 9 -

have fixed intervals of 67 nanoseconds, equivalent to a wave run of 20 meters between supply and return, and we scan them by means of a counter. By the interval quantity  $k$ , made by the counter from instant  $t = 0$  of wave generation at frequency  $f_2$  5 till the instant in which the echo is detected by proper comparating circuits (figure 6), we are thus in the position to evaluate the quantized obstacle distance  $R$ . In figure 5 we see schematically indicated the presence of two obstacles at the distances of 20 and 50 meters. Knowing that the echo signal 10 intensity lessens as the obstacle distance increases, we utilize receivers whose amplifications are increasing with the distance, i.e. with  $R$ , i.e. with  $k$ . In this way we obtain a first step toward the normalization of amplitudes of echo signals; this is essential for all the following circuits. The block diagram of the circuit that 15 performs what above described about the measures of  $R$  and  $Z$  is shown in figure 6.

The oscillator sends a square wave with the period  $\tau$  to the modulator, to the counter and to a frequency divider; from the latter is available the pulse repetition frequency  $1/T$  that is sent 20 to the counter, to the modulator and to the logics & display. The modulator, on the base of the two received signals, sends in sequence once at a time a tension pulse ( $\tau$ ) to each cavity A, B, C, whose echo received signal outputs are sent to the amplifiers which receive also the gain control signal from the counter. Then 25 the amplified signals enter into the comparator circuits which provide the identification of angles  $Z$  and of the distances  $R$ , utilizing the counter digital output. The three signals P.R.F.,  $Z$ ,  $R$

- 10 -

are collected and elaborated by appropriate logic circuits for the final presentation on the display.

An important characteristic of the system is that it must result not affected by the car-made noise; therefore, for  
5 electromagnetic exigencies, it is essential that the transmitted waveform be not amplitude modulated (by short pulses) but it has to be frequency modulated. Our aim has been therefore to devise the frequency pulsive modulation, and to obtain this by means of resonant cavities, whereas the resonant cavities are  
10 notoriously designed to operate by continuous waves and normally used in telecommunications or in Doppler radar systems.

In conclusion we have to clarify that the function diagram is in practice completely different from those of current radars:  
15 in fact there are not emitted high power radio frequency pulses (produced by klystrons, magnetron, etc.) alternated with dead periods, during which the transmitter is off and the echoes are heeded; moreover for determining the angle  $Z$  we have eliminated the need of a floating antenna (that would be bulky,  
20 delicate and unsightly) or a phase-array antenna (very expensive and low directional). The novities envisaged consist instead in the following: (a) transmitting continuous but frequency modulated waves (with the short pulses  $\tau$ ) by using simpler and more economical devices (resonant cavities) with  
25 the possibility of using high-gain high-directional antennas (horn type or parabolic type), (b) adopting the "amplitude discrimination" technics based on  $n$  beams, divergent and fixed,

- 11 -

for the angle Z determination. Therefore the system is not similar to the amplitude-comparison monopulse tracking radar, which employs overlapping antenna patterns to obtain the angular error. The system is not a copy of the radio-beacon, since our  
5 system is fully self-contained and does not require transponders, installed for example on others' vehicles. The system is neither a development of the radio altimeter based on Doppler effect, since the Doppler effect is not utilized: in fact we do not have to make only one measurement, as the distance aircraft-ground, but we  
10 have to perform as many and distinct measurements as the obstacles in continuous movements ahead of the driver, including their angular position Z, to obtaining the complete frontal map of the free space and of the occupied space, as clearly shown in figure 1.

15 It is understood that the system in accordance with this invention can be modified by the experts of this field to adapt it to any type of vehicle, on land, sea or air, therewith remaining in the competence of the present patent.

- 12 -

### Claims.

1. A vehicular anticollision radar system for driving in the fog, exhibiting a bidimensional obstacle display for direct vision or by reflection from the windscreen toward the driver, thus consenting him to see the display together with the road ahead,  
5 including: oscillator, modulator, counter, frequency divider, resonant cavities with Gunn diode and Schottky diode and varactor diode, amplifiers, comparator circuits, signal elaborating logic circuits, display, operating as follows: the oscillator sends a square wave with the period  $\tau$  to the modulator, to the counter  
10 and to a frequency divider; from the latter is available the pulse repetition frequency  $1/T$  that is sent to the counter, to the modulator and to the logic elaboration circuits; the modulator, on the base of the two received signals, sends in sequence once at a time a tension pulse ( $\tau$ ) to each cavity, whose echo received  
15 signal outputs are sent to the amplifiers which receive also the gain control signal from the counter; then the amplified signals enter into the comparator circuits which provide the identification of angles  $Z$  and of the distances  $R$ , utilizing the counter digital output; the three signals P.R.F.,  $Z$ ,  $R$  are collected  
20 and elaborated by appropriate logic circuits for the final presentation on the display.

2. Self-contained electronic fully solid state system, according to claim 1, wherein no need exists of moving antenna neither of transponders, also including a display with adjustable  
25 luminosity.

- 13 -

3. Self-contained electronic fully solid state system wherein use is made of  $n$  divergent microwave beams exploring  $2n-1$  sectors ahead the vehicle for identifying the obstacle angles  $Z$ , besides the distances  $R$ , with elaboration of the received echo signals by logic devices thereby including: (a) means for signalling of the obstacle distances  $R$  and their belonging sectors, (b) means for signalling in excess in case of echoes coming from common sectors, (c) means for the extension of signalling of an obstacle along its shade cone.

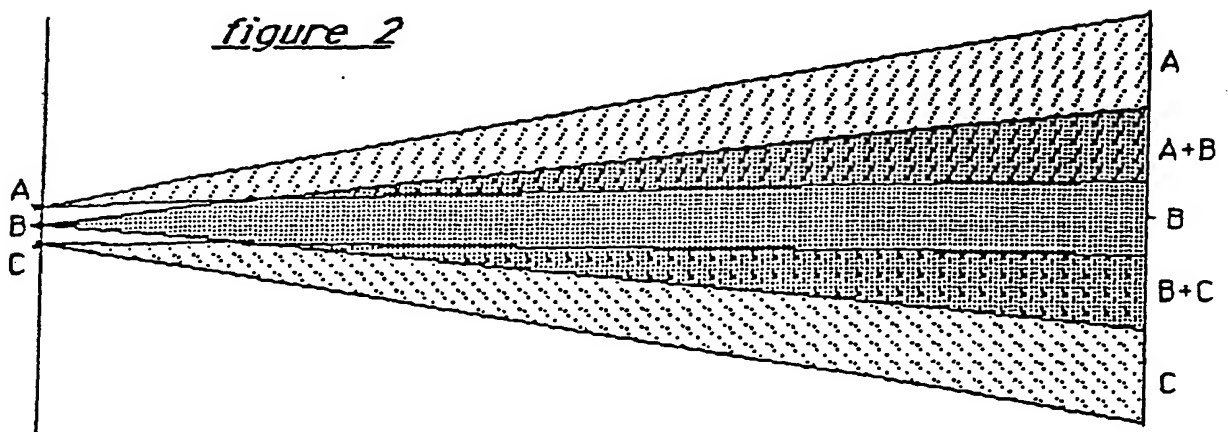
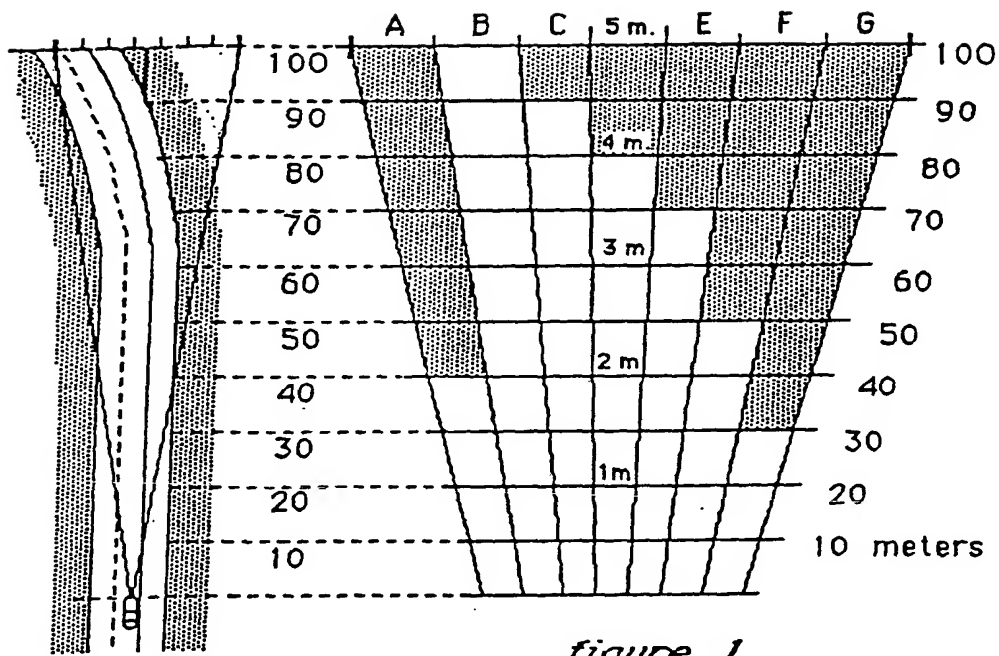
10 4. Presentation on display of logic elaboration results, in accordance with claim 3.

5. Employment and application in the system of resonant cavities furnished with Gunn diode, Schottky diode and possibly varactor diode, or other analogous systems and apparatus, that are more economical and at the same time efficient, apt to emitting pulsive frequency modulated microwaves in order to detect the echoes caused by obstacles through the beat effect.

6. Self-contained electronic fully solid state system wherein happens the beat effect between the received echo wave trains at frequency  $f_2$  and the local oscillation at frequency  $f_1$ , actuated by above mentioned devices.

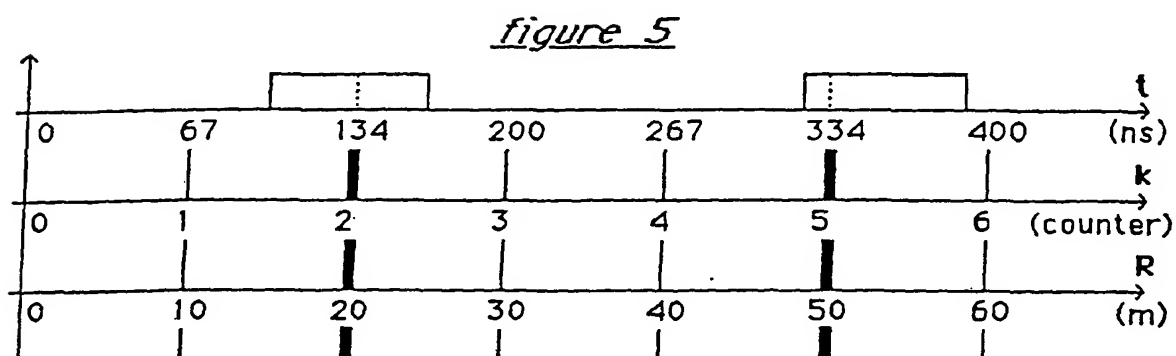
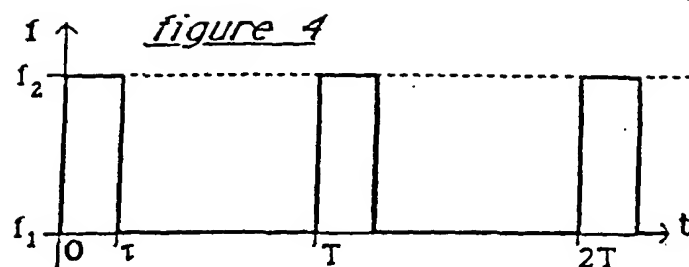
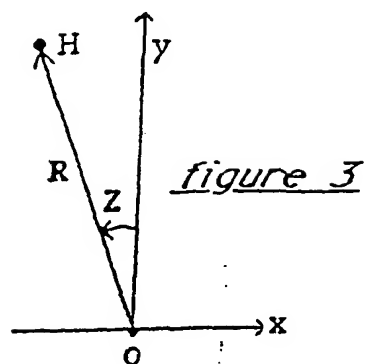
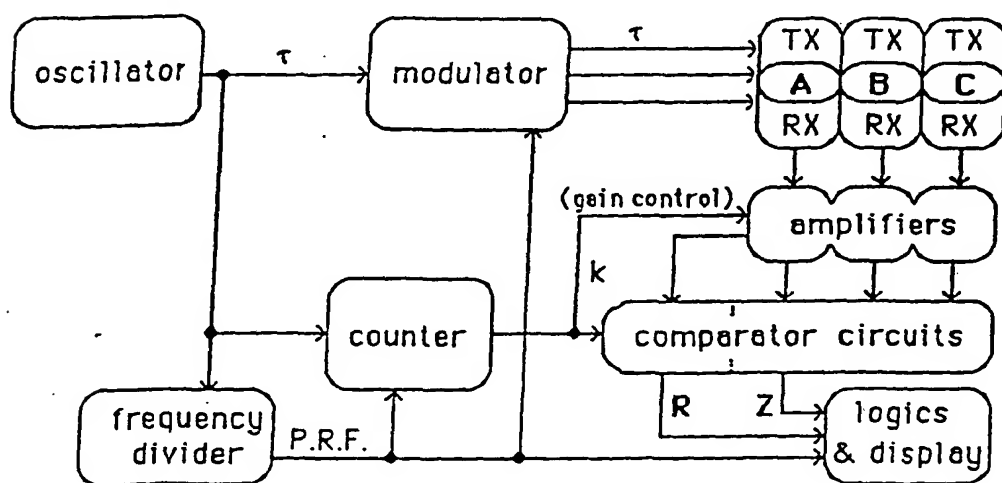
7. Self-contained electronic fully solid state system comprising digital comparators and counters for the measurement of distances  $R$  and angles  $Z$ .

### Drawings.





2/2.

*figure 6*

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/IT 89/00002

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC IPC <sup>4</sup> : G 01 S 13/93; G 01 S 7/04; G 01 S 13/87																										
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; font-size: small;">Minimum Documentation Searched <sup>7</sup></div> <table style="width: 100%; border: none;"> <tr> <td style="width: 30%; border: none;">Classification System  </td> <td style="border: none;">Classification Symbols</td> </tr> <tr> <td style="border: none;">IPC<sup>4</sup></td> <td style="border: none;">G 01 S</td> </tr> </table> <div style="text-align: center; font-size: x-small; margin-top: 5px;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *</div>			Classification System	Classification Symbols	IPC <sup>4</sup>	G 01 S																				
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<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT*</b> <table border="1" style="width: 100%; border-collapse: collapse; font-size: small;"> <thead> <tr> <th style="width: 10%;">Category <sup>8</sup></th> <th style="width: 70%;">Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup></th> <th style="width: 20%;">Relevant to Claim No. <sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td>WO, A, 80/01782 (COLLISION AVOIDANCE SYSTEMS) 4 September 1980 see pages 3-6, 9-18</td> <td style="text-align: center; vertical-align: top;">3</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center;">--</td> <td style="text-align: center; vertical-align: top;">1, 5-7</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td>US, A, 4674073 (NARUSE) 16 June 1987 see columns 2-3</td> <td style="text-align: center; vertical-align: top;">3</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center;">--</td> <td style="text-align: center; vertical-align: top;">1, 2</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>DE, A, 2557038 (LICENTIA PATENT) 23 June 1977 see figure; pages 3-5</td> <td style="text-align: center; vertical-align: top;">1, 2</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>IEEE Transactions on IECI, volume IECI-11, no. 1, February 1964, A.L. Merlo: "Automotive radar for the prevention of collisions", pages 1-6 see page 3, right-hand column, lines 26-33</td> <td style="text-align: center; vertical-align: top;">1, 6</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>EP, A, 0129251 (SIEMENS) 27 December 1984 see figures 1, 2; pages 7-10</td> <td style="text-align: center; vertical-align: top;">1, 5, 6</td> </tr> </tbody> </table>			Category <sup>8</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	Y	WO, A, 80/01782 (COLLISION AVOIDANCE SYSTEMS) 4 September 1980 see pages 3-6, 9-18	3	A	--	1, 5-7	Y	US, A, 4674073 (NARUSE) 16 June 1987 see columns 2-3	3	A	--	1, 2	A	DE, A, 2557038 (LICENTIA PATENT) 23 June 1977 see figure; pages 3-5	1, 2	A	IEEE Transactions on IECI, volume IECI-11, no. 1, February 1964, A.L. Merlo: "Automotive radar for the prevention of collisions", pages 1-6 see page 3, right-hand column, lines 26-33	1, 6	A	EP, A, 0129251 (SIEMENS) 27 December 1984 see figures 1, 2; pages 7-10	1, 5, 6
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A	IEEE Transactions on IECI, volume IECI-11, no. 1, February 1964, A.L. Merlo: "Automotive radar for the prevention of collisions", pages 1-6 see page 3, right-hand column, lines 26-33	1, 6																								
A	EP, A, 0129251 (SIEMENS) 27 December 1984 see figures 1, 2; pages 7-10	1, 5, 6																								
<div style="display: flex; justify-content: space-between; font-size: x-small;"> <div style="width: 45%;"> <p>* Special categories of cited documents: <sup>9</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"A" document member of the same patent family</p> </div> </div>																										
<b>IV. CERTIFICATION</b> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border: none;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="border: none; text-align: center;">24th April 1989</td> <td style="border: none; text-align: center;">30.05.89</td> </tr> <tr> <td style="width: 50%; border: none;">International Searching Authority</td> <td style="width: 50%; border: none;">Signature of Authorized Officer</td> </tr> <tr> <td style="border: none; text-align: center;">EUROPEAN PATENT OFFICE</td> <td style="border: none; text-align: center;">M. VAN MOL </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	24th April 1989	30.05.89	International Searching Authority	Signature of Authorized Officer	EUROPEAN PATENT OFFICE	M. VAN MOL																
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EUROPEAN PATENT OFFICE	M. VAN MOL																									

## III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	DE, A, 3414159 (LICENTIA PATENT-VERWALTUNGS-GmbH) 24 October 1985 see figures 1,3; pages 4-6 --	1,5,6
A	DE, A, 2327186 (LICENTIA PATENT-VERWALTUNGS-GmbH) 19 December 1974 see pages 2-8 --	1,3,5-7
A	DE, A, 2553302 (STANDARD ELEKTRIK) 2 June 1977 see pages 5-10 --	1-7
A	DE, A, 2951769 (FRAUNHOFER) 2 July 1971 see figures; pages 5-6 --	2
A	Patent Abstracts of Japan, volume 10, no. 135 (P-457)(2192), 20 May 1986, & JP, A, 60257381 (DAIHATSU KOGYO K.K.) 19 December 1985 -----	1-4





**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 23/05/89. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82